REACTIVE MULTIHOP ROUTING WITH MCDS IN MANETS

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Abstract

A wireless ad hoc network is a special type of network in which a collection of mobile nodes with wireless network interfaces may form a temporary network, without support of any fixed infrastructure or centralized control structure. The Dynamic Source Routing protocol (DSR) is a simple and efficient routing protocol specifically designed for multi-hop wireless ad hoc networks of mobile nodes. A connected dominating set (CDS) is used to minimize broadcast overhead. In this paper, we have described the design of multi-hop routing in mobile ah hoc network with the help of MCDS.

***Keywords*: Self-organizing, Virtual Backbone, multi-hop routing, dynamic routing, connected dominating set.**

1. Introduction

The wireless ad hoc network is completely self-organizing and self-configuring, requiring no existing network infrastructure or central control organization[4,5]. Network nodes cooperate with each other to forward packet and to allow communication over multiple hops that are not directly within wireless transmission range of one another The DSR and MCDS together allows nodes to dynamically discover (partially) a *source route* across multiple hops in the network to reach any destination in the ad hoc network.

In designing multi hop routing protocol, we used DSR and MCDS technique to design a new routing protocol that had very low overhead. This new protocol ensure high reliability of delivering data packets in the MANET.

2. MANETs Characteristics

2.1. *Dynamic topologies*

Since nodes are free to move randomly and organize themselves arbitrarily, the network topology may change rapidly and unpredictably. The links may be unidirectional or bi-directional.

2.2. *Bandwidth constrained*

Wireless link have significantly lower capacity than fixed hardwired counterparts and also, due to multiple access, noise, fading, and interference conditions etc. The wireless links have low throughput. As the mobile network is often simply an extension of the fixed network infrastructure, mobile ad hoc users will demand analogous services.

2.3. *Energy constrained*

Most of all the nodes in a MANET are batteries operated. In this scenario, the most important system criteria for optimization may be energy conservation. Thus, the routing algorithms should be more uncomplicated to avoid intensive computations. For example, overhearing transmissions requires a large amount of energy to receive and decode entire packets.

2.4. *Limited physical security*

Mobile nodes in wireless networks are generally more prone to physical security threats than wired networks. The increased possibility of spoofing, eavesdropping, and denial-of-service attacks should be carefully considered. Existing wired link security techniques are often applied within wireless networks to reduce security threats are not appropriate.

2.5. *Limited transmission range*

The range of the radio signal sent by a wireless device is limited. It can be deciphered correctly be receivers only when they are within a certain distance of the source. This is due to power reduction encountered by the radio signals as they travel through the medium.

2.6. *Multi-hop communication*

Multi-hope communication is required in MANETs because sender and receiver are not in direct transmission range.

2.7. *Unreliable medium*

In wireless media data can get lost due to interference from environment or other devices.

3. MANET Routing Protocols

3.1. *Destination Sequenced Distance Vector (DSDV)*

DSDV is a hop-by-hop distance vector routing protocol[1,3,12] requiring. Each node in this protocol periodically broadcast routing updates and updates routing table. The key advantage of DSDV deliver data packets when node mobility rate and movement speed are low in the network, it may fails to converge as node mobility increases. DSDV perform better when link-layer feedback not used. For that reason, it can be argued that DSDV is treated unfairly, because all the per-data-packet acknowledgments sent by the MAC protocol could be treated as routing overhead that should be charged against the other protocols. DSDV actually have a lower routing overhead than either TORA, DSR, or AODV while providing an equivalent packet delivery ratio. This effect occurs because the routing overhead would be dominated by the number of per-data-packet acknowledgments, which increases with the number of data packets sent. However, when stationary, the nodes in a real ad hoc network see significant rates of topology change due to wireless propagation effects and multi-path resulting from objects in the world moving around the nodes. These real-world effects would make the use of DSDV risky in a real ad hoc network.

3.2. *Temporally-Ordered Routing Algorithm (TORA)*

TORA is “an adaptive routing protocol for multi-hop networks” [1,9].TORA still delivered over 90%of the packets in scenarios with 10 or 20 sources. At 30 sources, the network was unable to handle all of the traffic generated by the routing protocol, and a significant fraction of data packets were dropped in these scenarios.

Packet loss in TORA resulted from two main sources. The 1st is short-lived routing loops caused by the delay between a link reversal at one node and the link-reversals at neighboring nodes. The second, and more serious one, is packet loss due to congestion caused by a positive feedback loop in the behavior of the IMEP reliable broadcast protocol used by TORA to distribute its routing updates. Given the increased probability of loss for broadcast packets in wireless networks , our experience with TORA/IMEP argues that routing protocols must be designed to be tolerant of the loss of their broadcast packets, rather than attempting to eliminate the loss via a reliable broadcast algorithm.

The performance of DSR was very good at all mobility rates and movement speeds we studied. The analysis of routing overhead bytes, however, shows the high cost of including a source route in each data packet and motivates the need for adding path-state to the protocol.

3.3. *Ad hoc On-demand Distance Vector (AODV)*

The AODV routing protocol [1,3,10] is a reactive MANET routing protocol AODV performs almost well with DSR at all mobility rates and movement speeds and accomplishes its goal of eliminating source routing overhead, but at high rates of node mobility it requires the transmission of many routing overhead packets than DSR requires[2]. The better performance of DSR with respect to AODV's due to DSR's ability to discover and use multiple routes and its use of Route Caches to contain Route Discoveries. The AODV protocol has undergone significant development since this study was performed. Some of the added features, such as an expanding ring search as suggested earlier by DSR , would improve AODV's performance on the scenarios in our study.

4. Minimum Connected Dominating Set (MCDS)

Blind broadcast [6] in a mobile ad hoc network is a common problem. Blind broadcast in a wireless ad hoc network means any mobile node will rebroadcast all received broadcast messages. One node may receive the same copy of a message from more than one neighbor, so unnecessary overhead is introduced.

A connected dominating set (CDS) [6,7,8] is used to reduce broadcast overhead. A common source of overhead in a wireless ad hoc network comes from blind broadcasts. Assuming the worst case, nodes in a wireless ad hoc network rebroadcast all received broadcast messages. Nodes may receive multiple copies of the same message form more than one neighbor. Therefore reducing redundant broadcast messages can reduce channel bandwidth consumption and increase bandwidth efficiency. It is possible to significant reduction of overhead by using the minimal connected dominating set (MCDS) [6,7,8] to reduce redundancy due to these blind broadcasts.

In a simple graph G = (V, E) where V is the set of nodes and E is the set of edges Assume a node set T is subset of V such that for all 'X' in V-T, there exist 'Y' belongs to V, such that edge (x,y) belongs to E [6]. This is the cover property for a CDS (connected dominating set). Set T is called a dominating set. Set T is called a connected dominating set (CDS) when T forms a connected graph. This is the connectivity property for a CDS. Figure 1 gives an example of a CDS. Black nodes 2 and 3 are connected and cover all nodes in the network. They form a CDS for this graph. Minimal set of CDS is known as minimal connected Dominating Set (MCDS). Since in given example CDS is already minimal so MCDS includes node 2 and node 3

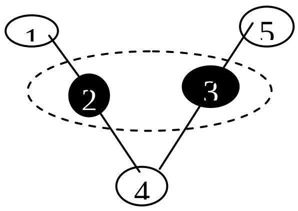

Figure 1: An example of CDS

MCDS in mobile ad hoc network is treated as a virtual backbone for whole network. A virtual backbone [8] structure on the ad-hoc network will useful, in order to support unicast, mulitcast, and fault-tolerant routing within the ad-hoc network. This virtual backbone differs from the wired backbone of cellular network. The hosts in the MCDS maintain local copies of the global topology of the network, along with shortest paths between all pairs of nodes.

5. Related work for MCDS construction

5.1 Distributed Approximation Algorithm for Constructing MCDS by Bo Gao & Yuhang Yang [13]

This distributed algorithm to construct approximation MCDS is described as two phases. In the first phase. The nodes in *S* are referred to as dominators, and the nodes not in *S* are referred to as dominators. In the second phase, each dominator tries to create paths connecting all its two hops away dominators and three hops away dominators by broadcasting a REQUEST DOMI message that includes a life flag (ttl) and a nodes list which will record the IDs of nodes visited by this message. This message is relayed at most two times in the networks, which means it travels at most three hops. When dominators receives a REQUEST DOMI message from a dominator for the first time, it appends its own ID to the nodes list that is included in this message and decreases the ttl value in the message by one and then broadcasts this message. When a dominator receives a REQUEST DOMI message from other dominators, it makes a decision whether to create a path to this dominator according to whether there already exists a shorter path . If there is no existing path between these two dominators, it will create a connecting path by informing the dominators included in the node list of the REQUEST DOMI message to change their states to connectors. Because the decision on creating a path is made by a dominator receiving the REQUEST DOMI message, we can create a unique path between any pair of dominators that depart from each other at most three hops away.

5.3 Global Ripple Algorithm for Minimal CDS [14]

The global ripple algorithm (GRCDS) assumes all nodes try to maintain identical copies of the entire network topology. This assumption is reasonable when the network mobility is low. When a link changes, the network is in a transient state in which some nodes have different copies of the topology database. We concentrate on low mobility cases for this algorithm at this stage. Here the terms of low mobility is defined as small link connectivity change rates with respect to the frequency to exchange control messages in the CDS algorithms. (This assumption is required for all proactive routing protocols. Otherwise, none of those proactive routing protocol can work properly) The algorithm runs locally with global topology information. There are two stages. In the first stage, the algorithm broadcasts a zero payload or "virtual" message starting at the node with the minimum node ID. The initiator of this message is marked as a potential CDS node. When a node broadcasts, all of its one hop neighbors can receive the broadcast message.

5.4 MCDS Algorithm by Wu & Li [15]

The Wu Li algorithm is implemented in a distributed manner. This algorithm uses two phases and assumes that all nodes know all the other nodes that are within their two hop range. In the first stage, a node is selected as a potential member of the CDS if and only if it has two nonadjacent neighbors. Nodes broadcast if they elect themselves as members of the potential CDS in the first phase. Two extensions are used in the second phase to reduce the size of the CDS. A node stays in the CDS unless a neighbor CDS node with a larger ID covers its entire neighbor set. As an extension, if the neighbor set of a node is covered by two adjacent CDS neighbors with larger IDs, this node may change itself to a non CDS node.List may be presented with each item marked by bullets and numbers.

6. MCDS based DSR routing

Dynamic Source Routing (DSR)[11] routing protocol belongs to on-demand routing protocols in multi-hop mobile ad-hoc networks. Source Routing is a technique in which the sender determines the complete sequence of nodes through which to forward the packets. In source- initiated on-demand routing, and send a request to closest MCDS nodes, the MCDS return back rout of destination node. Mobile nodes have to maintain route caches that contain the source routes of which the mobile is aware. DSR is composed of two main mechanisms: Route Discovery and Route Maintenance. MCDS is composed of minimum number of nodes connecting the whole network. These three mechanisms work together to allow nodes to discover and maintain routes in the mobile ad hoc network. In this part, the three mechanisms are applied on a network to find a optimal path.

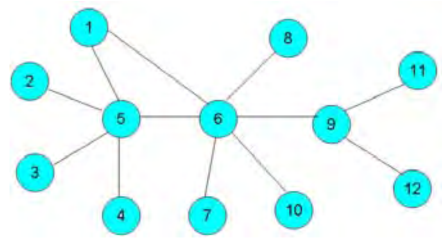

Figure 01: Ad hoc network nodes with there adjacent

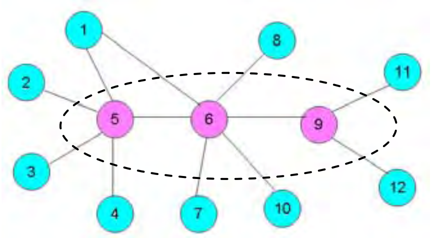

Figure 2: MCDS nodes in network

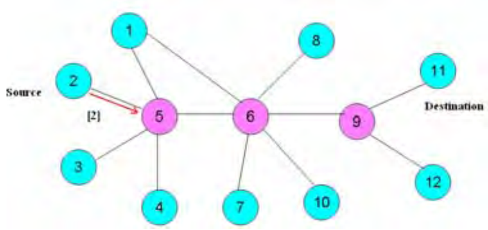

Figure 3: Source node communicate with MCDS

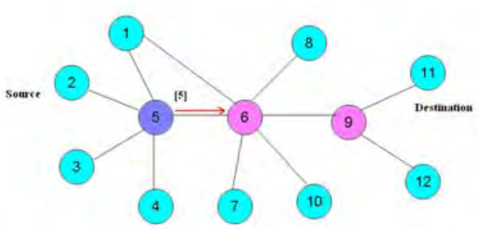

Figure 4: Intermediate node communication

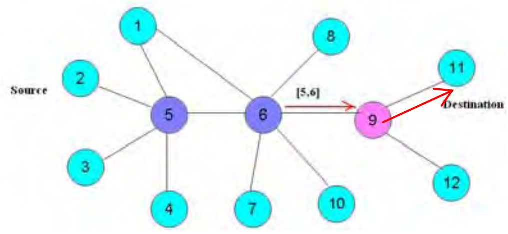

Figure 5: Intermediate node communication

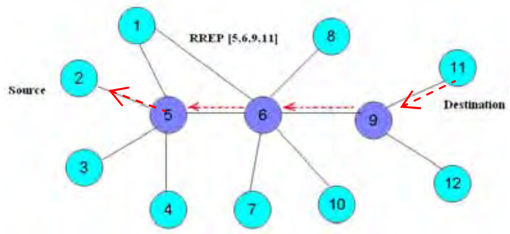

Figure 6: Destination node reply

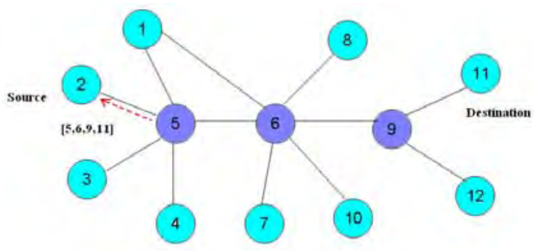

Fig. 7: MCDS reply to source node

Node 5,6,9 are the part of MCDS and these nodes are used as a routing nodes in DSR. Node 2 is a source node and node 9 is a destination node, they can communicate with each other with the help of 5,6,9 intermediate nodes.

7. Result

In this section, simulation is done which compares the no of intermediate nodes involve in transferring data from source to destination using DSR and DSR with MCDS approach. Random networks are generated simulation area and a random number of nodes are placed on this area. Bidirectional links are generated and two nodes are connected if they are in the wireless range of each other.

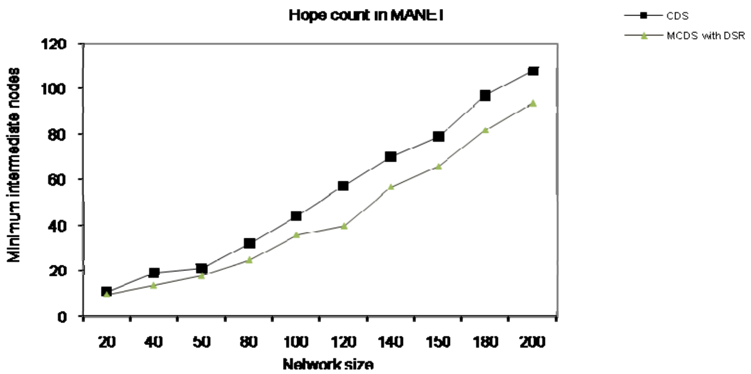

Figure 8: Minimum intermediate node required fro communication

Simulation shows the performance of DSR with MCDS is better compared to DSR approach Complexity analysis shows that DSR with MCDS has less time complexity in worst cases in compare to DSR. Figure 8 shows that there is a significant reduction in intermediate nodes involve in the communication between source to destination nodes.

8. Conclusion

To generate routes proactively or on-demand is extremely costly for energy and resource constraint nodes in a limited bandwidth shared wireless channel. Communication by blind broadcast that induces an intolerable overhead is not a feasible solution. A MCDS is required for cost effective communication and maintenance of the route. It is therefore, proposed to restrict the routing process in wireless ad hoc networks thereby, to the formation of a MCDS. MCDS can reduce the communication overhead, increase the bandwidth efficiency, reduce channel bandwidth consumption, decreases the energy consumption, increases network operational life, and provides better resource management. A connected dominating set is implemented as MCDS in Mobile ad hoc networks. This paper introduced the implementation of DSR using MCDS.

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